6-10-59

U.S. DEPARTMENT OF AGRICULTURE - FOREST SERVICE
PACIFIC SOUTHWEST FOREST AND RANGE EXPERIMENT STATION
Division of Forest Insect Research

# LINE PLOTS VERSUS STRIPS FOR SAMPLING MOUNTAIN PINE BEETLE DAMAGE IN LODGEPOLE PINE

By Galen C. Trostle, Entomologist

The determination of the size, location, and degree of forest insect infestation within the region is the primary objective of surveys conducted by the Station. To help meet this objective, various survey methods are tested to determine their efficiency. One test of this type was conducted on September 3 to 13, 1957 near Tuolumne Meadows, Yosemite National Park. Both a plot and a strip cruise was made of damage to lodgepole pine caused by the mountain pine beetle (Dendroctonus monticolae Hopk.). The results of these two cruises were then compared. It was originally anticipated that their accuracy could be determined from the number of trees found when the infestation was treated in the spring of 1958. However this did not prove to be possible.

The line plot method has been recommended for sampling bark beetle damage in the ponderosa and Jeffrey pine stands of California.1/ This type of sampling is well adapted to the open-stand conditions under which these species grow, particularly in old-growth stands. Experience has indicated that it is less applicable to dense, small size lodgepole stands, but the line plot method has not been thoroughly tested in these stands, at least in California. The mountain pine beetle outbreak in the Tuolumne Meadows area offered an opportunity to compare sampling methods, although the lodgepole in this area is considerably larger and more open-grown than in many other parts of the State. Since other regions use strip cruising to sample their dense stands2/ this method seemed to be the logical one to compare to plot cruising.

---

1/ R.C. Hall, 1953. An improved appraisal survey method for bark beetle damage in ponderosa and Jeffrey pine in the California Region. Calif. Forest and Range Expt. Sta., Berkeley, Calif. 3 pp. (mimeo.)

2/ T.T. Terrell, 1950. Training manual, bark beetle surveys Northern Rocky Mountain Region, Intermountain Forest & Range Expt. Sta., Missoula, Montana, 24 pp. illus. (mimeo.)

## Experimental Area

The area of infestation within the Dingley Creek drainage was selected as the experimental area. The terrain is quite moderate with little or no undergrowth. The lower end of the drainage is about 8,500 feet in elevation and the upper end is just over 10,000 feet. The lodgepole type in this drainage is well defined, except on the southeast. To the northwest the type changes abruptly to hemlock along the rocky rim of Conness basin; on the southwest and northeast the type is bounded by rocky outcrops and meadowland. These natural boundaries made it only necessary to mark the southeast edge, where there is neither type nor terrain change, to define the territory to be surveyed. The southeast boundary was defined by a string line established about halfway between Dingley and Delaney Creeks, beginning at the lower Young Lake's trail and extending in a direction of N45°E. to the upper Young Lake's trail. This line intersected the north corner of sections 4 and 5, T1S, R24E. A total of 2,700 acres is included within the experimental area.

The lodgepole pine in the Dingley Creek drainage has been seriously damaged, and some trees have been killed by heavy lodgepole needle miner (Recurvaria milleri Busck) defoliation for the past 6 to 8 years. For the past 3 years the mountain pine beetle has been on the increase in the area despite continued attempts to control it. The trees are overmature and many have particularly large diameters (40 to 50 inches d.b.h.) for lodgepole pine.

## Methods and Procedures

The string line on southeast boundary was established as a base line. Starting points for 18 cruise lines were marked at 10-chain intervals along this line. Cruise lines were run at 90° to the base line on northwest and southeast. Directions were determined with a hand compass and distances were paced.

Six men took samples: 3 summer assistants - W.J. Hogg, J.R. Batchelder, P.H. Lord, and 3 permanent survey personnel - R.C. Hall, R.E. Stevens, and G.C. Trostle. Two sampling methods were used:

1. One-fourth acre sample plots taken every $2\frac{1}{2}$ chains.

2. One-chain wide continuous sample strip.

The summer assistants first ran six cruise lines apiece using plot samples. These same men resampled the same lines in the opposite direction using strip samples. The direction was reversed to reduce the chance that infested trees might be remembered by their location. The permanent men ran random lines using alternate plots and strips. Each man recorded the actual time spent on the cruise, in addition to the usual information on number and size of infested trees.

## Results and Discussion

The data obtained for each method of sampling are summarized in tables 1-3. The most important difference between the two methods was in the time required to conduct the survey. Strip sampling took about 15 percent less time than did plot sampling. For each method, the time required by different individuals varied greatly, but generally strip sampling took consistently less time than plot sampling.

No significant difference was found in the number of infested trees obtained by the two methods. It should be noted that it was only possible to compare the results obtained by the one method against the results from the other, since the actual number of infested trees was not determined. This is due to the fact that when control was undertaken in the spring of 1958, it was found that the broods in many of the infested trees had failed to develop. Such trees were not treated, and unfortunately no record was kept of their number.

The results of this test are similar to those obtained by Knight3/ in more detailed tests with the Black Hills beetle in ponderosa pine. He found in addition that accuracy was not affected so much by method of sampling as by the number of cruise lines which were taken.

Considering the savings in time resulting from use of the strip method, and the lack of significant differences in damage estimates obtained by this method as compared to the line plot method, it would seem that the strip method warrants further use in California. It especially deserves further trials in the more densely stocked small diameter stands, where the line plot method may be less suitable than it is in open old-growth stands.

June 10, 1959
Berkeley, California

Attachments

---

3/ Fred B. Knight. 1958. Methods of surveying infestation of the Black Hills beetle in ponderosa pine. Forest Sci. 4(1): 35-41.

Table 1.--Number of infested trees, area cruised, and time required, with strip versus plot sampling methods in mountain pine beetle damaged lodgepole pine stands

| Cruiser | Line no. | Infested trees | Plots | Time per acre | Infested trees | Strips | Time per acre |
|---|---|---|---|---|---|---|---|
| | | Number | Acres | Minutes | Number | Acres | Minutes |
| A | 1 | 2 | 17.25 | 10.43 | 0 | 17 | 8.82 |
| A | 2 | 0 | 17.25 | 8.70 | 0 | 17 | 7.65 |
| B | 3 | 2 | 16.75 | 8.00 | 0 | 16.5 | 6.36 |
| B | 4 | 0 | 16.75 | 7.16 | 0 | 16.5 | 7.58 |
| B | 5 | 5 | 16.25 | 8.31 | - | - | - |
| B | 6 | 2 | 16.25 | 7.69 | 2 | 16.0 | 10.19 |
| A | 7 | 5 | 15.75 | 10.29 | 3 | 15.5 | 7.74 |
| A | 8 | 3 | 15.75 | 8.57 | 8 | 15.5 | 7.10 |
| C | 9 | 6 | 14.75 | 6.10 | - | - | - |
| C | 10 | 3 | 15.0 | 6.00 | - | - | - |
| C | 11 | 11 | 13.75 | 6.18 | 12 | 14 | 7.50 |
| C | 12 | 6 | 14.0 | 6.00 | 12 | 14.5 | 3.86 |
| C | 13 | 10 | 14.0 | 8.93 | 8 | 14.5 | 4.62 |
| C | 14 | 7 | 14.0 | 7.57 | 10 | 12 | 5.17 |
| A | 15 | 9 | 13.5 | 8.52 | 6 | 13.5 | 5.93 |
| A | 16 | 5 | 13.5 | 9.63 | 6 | 13.5 | 5.18 |
| B | 17 | 8 | 13.25 | 9.28 | 3 | 13 | 6.15 |
| B | 18 | 1 | 14.25 | 10.88 | 14 | 13 | 11.15 |
| D | 7 | 1 | 15.75 | 5.08 | - | - | - |
| D | 8 | - | - | - | 2 | 16.4 | 4.88 |
| E | 9 | 12 | 15.25 | 10.16 | - | - | - |
| E | 10 | - | - | - | 7 | 16.6 | 5.42 |
| D | 11 | 2 | 14.25 | 7.72 | - | - | - |
| F | 12 | 10 | 10.00 | 7.50 | - | - | - |
| D | 12 | - | - | - | 4 | 14.5 | 7.24 |
| F | 12 | - | - | - | 8 | 10.1 | 8.71 |
| E | 13 | - | - | - | 25 | 14.0 | 8.57 |
| E | 14 | 8 | 13.25 | 9.81 | - | - | - |
| Total | | 118 | 340.5 | 188.51 | 130 | 293.6 | 139.82 |
| Average | | 5.13 | 14.8 | 8.20 | 6.5 | 14.7 | 6.99 |

Table 2.--Summary of strip and plot data in table 1.

| Method of sampling | Average tree per acre | Standard error | Sample error | Total infested trees on area | | | Time required per acre | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Max. | Min. | Ave. | Max. | Min. | Ave. |
| | | | Percent | | | | Minutes | | |
| Plots | 0.346 | ±.055 | 16 | 1,083 | 785 | 934 | 9.99 | 6.40 | 8.20 |
| Strips | 0.443 | ±.095 | 21 | 1,450 | 940 | 1,196 | 8.71 | 5.29 | 6.99 |
| | | | | | | | | | 1.21* |

* A "t" value of 2.25 was obtained with 41 degrees of freedom.

At 0.05 the critical "t" is 2.021 with 40 degrees of freedom.

Table 3.--Cruising time and number of infested trees, by individual cruisers and methods

| Individual | Time per average acre | | Average infested trees per acre | |
|---|---|---|---|---|
| | Plots | Strips | Plots | Strips |
| | Minutes | | Number | |
| A | 9.36 | 7.07 | 0.26 | 0.25 |
| B | 8.55 | 8.29 | 0.19 | 0.25 |
| C | 6.80 | 5.29 | 0.54 | 0.76 |
| D | 6.40 | 6.06 | 0.10 | 0.19 |
| E | 9.90 | 6.99 | 0.70 | 1.04 |
| F | 7.50 | 8.71 | 1.00 | 0.79 |
| Average | 8.20 | 6.99 | 0.35 | 0.44 |